Project: Assessment of the lateral-torsional stability of steel I-beams with sequential sinusoidal web openings

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Summary

Beams with sinusoidal web openings are perforated beams manufactured from a single web cut, which leads to the production of taller profiles with a better strength-to-weight ratio compared to the profiles in which they originated. There are few studies in the literature about this type of profile, especially in relation to its behavior in terms of global stability and resistant capacity to lateral-torsional buckling (LTB). This occurs because the research carried out so far deals mostly with local instabilities. Bearing in mind the importance of understanding the behavior of perforate beams with sinusoidal web openings subject to LTB, a broad parametric study was carried out in this work, through numerical analysis in the commercial finite element software ABAQUS. The study was carried out with 18 doubly symmetric parallel flange profiles, in a wide range of lengths and opening properties. In addition, initial imperfections were considered in the model, such as residual stresses arising from the manufacturing process and geometric imperfections. Through the large number of models studied and the results obtained, it was possible to evaluate the main existing analytical procedures, both for determining the elastic critical moment and the nominal resistant capacity to LTB of this type of structural member. With this, adaptation methods and calculation procedures were proposed in order to enable the determination of the critical moment of the sections, as well as methods for determining the ultimate capacity of perforated beams with sinusoidal web openings. To determine the ultimate capacity, modeling using Artificial Neural Networks was used, in view of the large database generated through the work. In the study, it was observed that the resistant capacity to LTB is considerably reduced, if compared to the uniform moment situation, if transverse loads are used outside the shear center (upper flange). This situation is even more critical for the case of short span profiles, where the possibility of interaction between local and global failure modes was verified. The modeling by artificial neural networks showed excellent performance and the prediction of the resistant capacity of the sections proved to be feasible through a developed software application.